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TIIVISTELMÄ

Tutkimus tarkastelee yrityskauppojen vaikutuksia yritysten T&K-investointeihin. Tutkimus arvioi erikseen tämän vaikutuksen tuntumista yrityskaupan kohteessa ja ostajassa. Yrityskaupat on jaettu kotimaisiin ja ulkomaisiin. Ulkomaisissa kaupoissa toinen osapuoli on ulkomainen yritys. Kotimaiset kaupat on vielä jaettu tarvittaessa yritysten toimipaikkojen maantieteellisen tai teknologisen läheisyyden mukaan sisäisiin ja välisiin kauppoihin. Kotimaisiin kauppoihin kuuluvat myös sellaiset järjestelyt, joissa toinen osapuoli ei ole yritys. Saadut tulokset osoittavat, että yrityskaupat pyrkivät lisäämään ostajan T&K-investointeja ja taas vähentämään tai pitämään ennallaan kaupan kohteena olevan yrityksen T&K-investointeja. Selvin positiivinen vaikutus yrityskaupalla on sellaisen kotimaisen yrityksen T&K-investointeihin, joka ostaa ulkomaisen yrityksen. Vastaavasti yrityskauppa ei vaikuta juuri lainkaan sellaisen kotimaisen yrityksen T&K-investointeihin, joka tulee ulkomaisen yrityksen ostamaksi. Yrityskauppojen vaikutus yrityksen T&K-investointien tasoon on keskimäärin selvästi positiivisempi kuin T&K-investointeihin suhteutettuna yrityksen liikevaihtoon (T&K-intensiteettiin). Vaikutus T&K-intensiteettiin on negatiivinen jopa sellaisen kotimaisen yrityksen kohdalla, joka ostaa toisen koimaisen yrityksen, puhumattakaan yrityskaupan kohteesta näissä tapauksissa.

ABSTRACT

This study considers the impact of M&As on a firm's R&D investments. We have analysed the impacts of the incidences in which a firm becomes a target and, on the other hand, an acquirer. M&As are classified in our study as being either domestic or cross-border. In addition, domestic M&As are classified – if needed – according to geographical and technological proximity. The results obtained show that M&As tend to increase acquirers' R&D investments, and decrease targets' R&D investments or keep them unchanged. The clearest positive effect is related to the incidence in which a Finnish firm buys a foreign firm. On the other hand, when a foreign firm buys a Finnish firm, the impact is zero.

JEL Codes: G34, O32
Keywords: M&As, R&D investments

1. INTRODUCTION

This study considers the impacts of M&As on a firm's R&D investments. M&As are classified in our study as being either domestic or cross-border. In addition, domestic M&As are divided - if needed – into horizontal and other types, or alternatively, intra-regional and other types. This study analyses the M&A data for acquirers and other target firms separately.

The previous research (see Lehto and Lehtoranta, 2004 and 2006) – which has discovered that M&As are used as a scheme to internalise synergy gains by technology transfers – has very much motivated us to consider the impacts of M&As on firms' R&D investments. The literature on the R&D impacts of M&As is rather scarce. Bertrand and Zuniga (2006) analysed the impacts of both domestic and cross-border M&As on R&D investments in OECD countries with industry level data. According to their results, the impact of M&As on R&D is mainly not different from zero. Only in low-technology sectors have domestic M&As a weak and positive impact on R&D investments.

The above results are not surprising but, on the other hand, owing to the ambiguities of the theory one cannot have expected them to be so, either. The theory suggests that an M&A (or co-operation with co-ordination in the production market as well) of two competitive firms does not necessarily lead to a reduction in R&D investments if the M&A (or a co-operative agreement) eliminates unintended knowledge spillovers sufficiently from one party to another (see D'Aspremont and Jacquemin, 1988). In horizontal mergers, R&D investments are, however, substitutable, and so it is not surprising that the need to eliminate duplication of R&D dominates so that firms cut their R&D (see also Katz and Ordover (1990) and Kamien *et al*. (1992)). When a target and a purchasing company belong to complementary industries, the R&D of these firms is also apparently complementary, and so the impact of an M&A on R&D becomes positive[1].

Horizontal mergers reduce competition, while vertical mergers often have no competition impact. This does not make it easier, however, to draw conclusions about the R&D impacts of M&As, because the theory does not give any unambiguous statements about the effect of competition on R&D. Arrow (1962) had already presented a hypothesis according to which the hardening of competition would encourage firms to innovate. On the other hand, according to Gilbert and Newbery (1982) firms safeguard their market force by investing in R&D and restraining market entry in this way. Aghion *et al*. (2002) have derived a U-shaped curve which expresses the relationship between the state of competition and incentives to innovate.

[1] Katz and Ordover (1990) have also noticed that R&D effort may become complementary when one firm learns from another's success.

The organizational and institutional aspects of M&As have recently been given increasing emphasis. Kogut and Zandler (1992) have drawn attention to the difficulties of combining the possibly different business cultures of target firms and acquiring firms. The existence of big cultural and organizational differences makes it more difficult for them to communicate, which then decreases the efficiency of technology transfers and assimilation of new technology. This also makes firms put more emphasis on the short run, which is seen to reduce R&D efforts (see also Hoskisson *et al*. (1991) and Hoskisson and Hitt (1998)). The geographical distance between a target and acquiring firm could also enlarge the distinction in the corporate cultures of parties involved in an M&A. For this reason one can expect that domestic mergers have larger impact on R&D investments than cross-border M&As. In addition, owing to informational incompleteness, the purchasing firm is in cross-border M&As not so capable as in domestic M&As to rationalise R&D activities, and in the case of duplication to reduce R&D.

On the other hand, Shleifer and Summers (1988) have argued that change in control associated with, especially, hostile takeovers offers an opportunity for a new management to renege on implicit and explicit labour contracts. This argument can also concern the maintenance of such activities as R&D. The geographical distance may also be relevant in this context. It is easier for the new management to curtail activities in remote locations than in the neighbourhood where they also belong. On the whole, it is thus difficult to derive clear implications of the impacts of various kinds of M&As on R&D from the theory.

As far as the impacts of cross-border M&As - in which either Finnish firms are purchased or Finnish firms buy foreign firms – are concerned, the fact that Finnish firms are on the technological frontier in many special fields can be relevant. It is possible that this favours the Finnish location of R&D after a cross-border M&A. But, on the other hand, a remote market place may create a tendency to transfer activity - both R&D and employment - out of Finland. All in all, once again the theory cannot say decisively what the direction of the impact of an M&A is on employment and on R&D.

The above discussion does not give any clear predictions about the impacts of an M&A on R&D investments. We think, however, that horizontal M&As have a more negative or less positive impact on R&D than other domestic or cross-border M&As. The same may concern intraregional M&As compared with other types of M&As. In intraregional and in horizontal M&As substitutability between the target's and the acquirer's R&D activities is obvious, and the tendency to get rid of the overcapacity that has arisen is believed to dominate the other impacts of an M&A on R&D. We have introduced various other factors that play a relevant role, and it is highly plausible that, for example,

the effects of cross-border M&As may deviate in any direction from the effects on domestic M&As, on the whole.

In our study we consider the impacts on targets and acquirers separately. This naturally raises the question about the possible difference between the impacts on target firms and on acquirers. Is the direction of possible technology transfer relevant in this context? Let us consider an asymmetric situation in which an acquirer has invested in R&D and also suffered sunk costs associated with starting these activities, whereas the target's R&D activities are insignificant. When the knowledge possessed by an acquirer is then utilized in the target firm's production, M&A easily increases the marginal benefits of the purchaser's R&D. So, in this case M&A tends to increase R&D in the acquiring firm. On the other hand, when the motive of an M&A is to obtain the target firm's knowledge – which is utilized in the acquiring firm's production - the opposite may occur. If the direction of the technology transfer is, for example, primarily from a target firm to an acquiring firm, the M&A will also, on the average, raise R&D in the target firm. Lehto and Lehtoranta (2004 and 2006) have shown that the direction of the knowledge transfer which an M&A implements can be in either direction and that the new technology flows from targets to acquirers generally in non-processing industries and that innovations are then by nature rather product than process innovations. On the other hand, in processing industries, process innovators acquire target firms with low R&D intensities. Would the R&D impact of an M&A be - due to this asymmetry - different in target firms than in acquiring firms? One can expect that product innovations are, to some extent, by their nature, "disposable goods" compared with the projects to develop processes which continue over time. If this is true, it is possible that M&As hit target firms' R&D more severely than acquirers' R&D.

Considering the impacts of M&As it is also noteworthy that M&As are implemented on the conditions of an acquiring firm. Does it follow from this that a purchasing firm's R&D activities are not hit so badly as a target firm's R&D activities?

R&D activities are typically located near the firm's head office and these activities also belong to the firm's core activities. This, together with the fact that the essence of an M&A is more or less to replace a target firm's management and strategy by the acquiring firm's management and strategy, easily endangers the R&D activities in the target firm's establishments which, after an acquisition, have fallen too far from the firm's management. Even this scenario is sensible only if some kind of informational incompleteness and lack of trust in the target firm's capabilities prevent the acquiring firm from expanding and developing R&D activities in the establishments which belong to the target firm.

2. DATA

The data specifies separately all the establishments that have been as targets of M&As. In some cases the acquisition has concerned only a part of the firm's establishments. Among the acquirers, all the establishments of the acquiring firm are taken into consideration.

Our data on M&As originates from the magazine *Talouselämä*, which is published on a weekly basis. M&As are defined as being based on an ownership share of at least 50%. The magazine reports all M&As in which either the acquiring or the acquired firm is a Finnish one, or in which either the acquiring or the acquired firm is owned by a Finnish company. The magazine covers all sectors. The only major restriction is that the magazine *Talouselämä* does not keep a record of M&As in which either the acquirer's or the target's turnover is less than FIM 3 million (or around 510 000 Euros). In addition, we have omitted from the analysis those firms that have been targets of M&As two (or more) times within a single year in order to avoid conflating the effects of different types of M&As on turnover. The number of those cases is very small, however.

In the original data, the target firm's or the acquiring firm's involvement with various types of M&A has been determined first at the establishment level. In the empirical firms level analysis of this study, the establishment level M&A dummies for various kinds incidences are averaged at the firm level.

The data allows us to separate different types of M&As that are classified according to the technological or regional proximity of target firms and acquiring firms or their establishments. In this study we sort M&As into cross-border M&As and domestic M&As, which are divided at least into regular domestic M&As – in which a purchaser is another domestic firm – and into internal restructurings. In the data set for target firms a firm is part of a cross-border M&A when it is purchased by a foreign company, whereas in the data set for acquiring firms the cross-border M&A means an incidence in which a Finnish firm buys a firm from abroad. Internal restructurings refer to ownership changes associated with the transformation of a firm's organizational form without the involvement of another company, for instance, management buy-outs that were popular throughout the 1990s, and a smaller number of cases where an individual Finnish investor is buying. Because a target transforms into an acquirer in internal restructuring, the same firm often appears as the data set for targets and, on the other hand, in the data set for acquirers as part of an internal restructuring. In addition, the cases in which juristic persons – not firms – buy firms are classified as internal restructurings. These cases are then included in the data set for targets, but not in the set for acquirers.

Regular domestic M&As are divided – if needed - according to technological or geographical proximity. In the data this division is made originally at the establishment level. An establishment is defined as being part of a domestic and horizontal M&A when the establishment belongs to a target

firm and is located in the same industry (at the 3-digit-group NACE level) as some of the acquirer's establishment. In an intraregional domestic M&A a target firm's establishment is located in the same NUTS4 region as some of the acquirer's establishment. When domestic M&As are divided according to technological or geographical proximity this practice leads to a situation in which a multi-plant firm has been simultaneously part of, for example, a horizontal and a non-horizontal M&A. Domestic M&As – both horizontal and intraregional – are defined in the data set for acquirers in the same way as they are defined for target establishments. This also applies to internal restructurings.

Our data set for M&As also covers such cases in which only a part of the target firm is purchased and we have specified in disclosures at the establishment level which part of the target firm is actually purchased. However, all such establishments that belong to a firm which acquires another firm or only a part of another firm (e.g. one establishment) are defined as belonging to a purchasing firm.

The total number of establishments that were targets of mergers and acquisitions was 7923 over the period 1989-2003. Of these, 2815 establishments were part of a horizontal domestic M&A and 2554 establishments were part of another domestic M&A. Only 765 establishments were purchased by a foreign firm and 1789 establishments were targets of internal restructuring. In the acquirers' data set the number of establishments that were part of a cross-border M&A rose to 9697. The large number is explained by the above-mentioned unrestricted way to define establishments as being part of acquiring firms. In addition, the fact that many large companies buy abroad increases the number of establishments in the cross-border category. The same factors partly increased the number of establishments that belong to other types of M&As as purchasers. In 1989-2003 6647 establishments were part of an acquirer in domestic horizontal M&As and 41798 establishments were part of an acquirer in other domestic M&As. The number of establishments involved in internal restructuring as a purchaser was 4393.

Structuring of M&A data is made possible by the fact that the magazine *Talouselämä* lists the names of the companies that have been involved in M&As. Hence, it is possible to link the firm codes manually to the names of the companies listed by the magazine. We have extensively used the trade register maintained by the National Board of Patents and Registration of Finland in this process. In addition, we have used the Business Register by Statistics Finland (SF). In particular, in complicated multi-plant mergers and acquisitions the additional information from the Business Register has been necessary to identify the parties of M&A on the establishment level. The information about M&As is linked to the Business Register by the use of firm codes. Firms can further be linked to their establishments by the use of registers maintained by SF. In addition, the matched data is linked to Employment Statistics, also maintained by SF, which compiles information on the economic activity

of individuals and their background characteristics such as education. The information about firms' balance sheets and income statements is obtained from SF's Financial Statements data set. The data for firms' R&D investments are obtained from SF's R&D survey. It must be noted that after the rest of the data has been linked to R&D investments data the number of observations decreases dramatically.

We have also constructed the panel data on firms' R&D stock to obtain an even more comprehensive data set for firms' R&D activity. In forming this data set we have imputed values for R&D investments where data are missing. Imputations are, however, done only if at least one value for a firm's R&D investment is present. Missing observations of R&D investments are then approximated by means of observations in other years. Firstly, we filled in the gaps between observations with linear interpolation. If the values of the first or last years were still missing we approximated the missing R&D expenditures from the start-up year of the firm until the first observation or, on the other hand, from the last observation until the closed-down year of the firm or at most until the year 2004 by carrying on the same value of the first or, respectively, the last observation at fixed prices. In deflating the current values of R&D expenditures we used the private sector's earning-level index. The firm's own R&D stocks for all the firms included at least once in an R&D survey were compiled for the period 1985–1999 by using the deflated values of the original and approximated R&D investments and the annual depreciation rate of 0.15.

3. METHOD

Ordinary Least Squares (OLS) and Tobit to evaluate the impact of an M&A on R&D investments

We consider the direct and indirect impacts of an M&A by following various approaches. Firstly, in trying to find out the genuine impact of the M&A on the outcome variable (R&D investments) we rely on a difference-in-difference approach. By controlling a firm's inclination of being involved in an M&A, we can measure the direct impact of the M&A on the outcome variable as a difference between the total impact (the impact of the M&A plus the change in time induced by other controls) on exposed firms and, on the other hand, the impact in time induced by other controls on the firms which are not exposed to M&As. To elicit these impacts on the firm's R&D investments we estimate the following model:

$$\ln(rd_{it}) = \alpha + yrd_i\beta + yr_{it}\beta + z_{it}\Pi + e_{it}. \quad (1)$$

Above, rd_{it} denotes firm i's R&D investments in year t. The constant term a gives R&D investments for the firms that are not involved in M&As. Variable yrd_i is a vector of dummies for different types

of M&As. This variable gets zero value when a firm will not be part of a given kind of M&A in any year and it is one for those firms which will be part of a given kind of M&A in some year during the time interval considered. Typically $f = (f_1, f_2, f_3, f_4)$ is a vector of four types of M&As. The coefficient f_j gives a constant difference in R&D investments between a firm which is not part of the j type of M&A and a firm which is involved in the j type of M&A.

The variable yr_i is a vector of dummies for different types of M&As. This variable is first specified at the establishment level and is originally zero for a given kind of M&A, but increases by one when an establishment becomes involved in a given kind of M&A in a year considered. If an establishment is involved in a given type of M&A a second time, the value of this variable rises to two and so on. This variable then stays at zero value when an establishment will not be part of a given kind of M&A in any year. The firm level variable yrd_i is then derived from the establishment level dummies by calculating the firm level average. ß is a vector ($ß_1$, $ß_2$, $ß_3$, $ß_4$) and the coefficient $ß_j$ gives the j type of impact of an M&A on the R&D investments of a firm that is exposed to this type of M&A. Above in (1) z_{it} represents a vector for other controls, of which some are firm-specific, some are industry-specific and some (the year dummies) are the same for all firms.

When (1) is estimated by Ordinary Least Squares (OLS) - both variation within time and between firms is taken into consideration - so ß reflects the impacts of M&As, which come into force after the event considered and not necessarily exactly in year t. This is an advantage of the model (1), which is estimated in levels and not in differences. The weakness of the OLS model is the assumed exogeneity of M&A events. The possible lack of contemporaneous exogeneity would make the estimator inconsistent.

Because for many firms R&D investments have been at the zero level, we have also estimated model (1) as a Tobit model. Then the data for R&D investments is regarded as left-censored so that zero value is the censoring point.

Fixed effect model to evaluate the impact of an M&A on R&D investments

We also estimated a fixed establishment effect model to measure the impacts of an M&A. This model can be presented in the form

$$\ln(rd_{it}) = m_i + yr_{i,t-1}\beta_1 + yr_{i,t-2}\beta_2 + z_{i,t-1}\Pi + z_{i,t-2}\Pi + e_{it}. \quad (2)$$

In (2) we consider the lagged (firm effect) changes of an M&A rather than the contemporary change. The other controls (other than year dummies) are also lagged by one or two years. We believe that

lagging reduces the inconsistency owing to the plausible lack of strict exogeneity. On the other hand, M&A events that are registered occur on some date within year t, and so the change in R&D investments within year t does not necessarily reflect the impact generated by an M&A event during the same year. It is evident that the real impact of an M&A materializes during the following years. The fixed effect panel estimator registers only the impact that occurs strictly in the year specified - unlike model (1) estimated by OLS – and, for that very reason, M&A dummies are lagged in model (2). The advantage of the fixed effect estimator is that it allows the unobserved establishment-specific effect to be correlated with explanatory variables. In fact, the invariant explanatory variables will fall out of the fixed effect model. Equations (1) and (2) are estimated separately in the data sets for targets and acquirers.

Again we have also estimated the fixed effect model regarding the data set for R&D investments as left-censored so that zero value is the censoring point.

Propensity score matching to evaluate the impact of an M&A on R&D investments

The selection of firms for acquirers and targets is contingent on firm characteristics. Foreign companies, for example, tend to take over certain Finnish companies with particular observable characteristics. The introduced matching procedure takes into account the endogeneity of an M&A decision. To estimate the impacts of an M&A the matching procedure explicitly controls the selection of a firm to become part of an M&A. We estimate propensity score matching models when studying the effect of M&As on the R&D investments of target firms and acquiring firms.[2] Propensity score matching aims to mimic a random experiment by constructing a control group from the group of untreated companies and to ensure that the control group is as similar as possible to the treatment group with respect to observable characteristics. In our case the treatment is a situation in which a firm has been the target or the acquirer of a particular type of M&A.

To construct a control group for firms that have been targets of M&As over the period 1989-2003, we have included all domestic firms from the Business Register by SF that have a turnover of at least FIM 3 million (or around 510 000 Euros). This is the very same limit that is used by the magazine *Talouselämä* when it reports M&As. The data set for M&As is also linked to the R&D survey of the Statistics of Finland, which remarkably decreases the number of observations. In the analysis of the target firms, only such firms are included in treatment set of firms that have not been the target of any other kind of M&A in a given year. In addition, the controls also are always chosen from the set of firms that have not been the target of any kind of M&A during time period t-1, …, t+2. The same procedure is followed in the analysis of acquiring firms.

[2] Caliendo and Kopeinig (2005) provide a survey of these methods.

Matching that is used to analyse the effect of different types of M&As on R&D investments can be conducted as follows. First, Probit models - for being a subject of each type of M&A - were separately estimated to construct the control group. The firm-level explanatory variables which explain the likelihood of becoming the target or the acquirer of a particular type of M&A are not reported. We use the solely linear part of the prediction following Diamond and Sekhon (2005), because the compression of the probability mass around the value of zero and one could cause problems for matching. Propensity scores are used with the nearest-neighbour matching method when one is calculating the average treatment effect on the treated.

Second, the R&D investments of those that have been a part of an M&A (i.e. the treatment group) was compared with the levels of those firms that have a similar propensity (based on the predictions of Probit models) to be in the pool of firms taken over by another firm, but are not currently in the pool of those firms (i.e. the control group). After some experiments, we end up using in our analysis the program developed by Adadie *et al*. (2004) that was written for Stata in order to perform matching by the nearest-neighbour matching method and to calculate the corresponding average treatment effect on the treated. This procedure allows one to match exactly inside the industries and years, to remove the bias that arises when the unobserved time-variant and possibly industry-specific factors have an asymmetric impact on the propensity score and on the outcome variable. In the nearest-neighbour matching method one treated unit can be matched to more than one untreated unit. After we looked at the robustness of the results, the number of controls was set to be five for each treated unit. This method is considered in Lehto and Böckerman (2006) in more detail.

4. RESULTS

4.1. The basic model - differences-in-differences estimates

The main emphasis of our analysis is in the differences-in-differences estimation using OLS and Tobit estimators. The results from the models in which M&As are divided into cross-border M&As and domestic M&As, into internal restructurings and into outsourcing (only in the data set for target firms) are reported in Tables 1 and 2. The controllers in these models describe the industrial structure mostly and such firm-level properties on which the management has not a strong influence. While R&D investments are explained, the firm's turnover is controlled in three different ways. First, the impact of turnover on R&D investments is allowed to be determined freely (the first and fourth columns in Tables 1 and 2). Next, the turnover variable is omitted (the second and fifth columns in Tables 1 and 2) so that the absolute level R&D investments are actually explained. Finally, the coefficient of the turnover variable is restricted to be one (the third column in Tables 1 and 2). In this case the R&D intensity – the ratio of R&D investments to turnover – is explained.

Table 1. The impact of M&As on the R&D investments of target firms
Differences-in-differences model

	OLS	OLS	OLS	TOBIT	TOBIT
d-foreign	0.031 (0.08)	-0.020 (0.04)	0.075 (0.20)	-0.083 (0.18)	-0.182 (0.38)
d-domestic	-0.307* (1.71)	-0.138 (0.68)	-0.505*** (2.82)	-0.420** (1.99)	-0.190 (0.86)
d-internal	0.050 (0.18)	0.254 (0.81)	-0.188 (0.65)	0.069 (0.22)	0.360 (1.09)
d-outsourcing	0.604*** (2.85)	1.149*** (4.56)	-0.047 (0.24)	0.717*** (3.18)	1.521*** (6.49)
e-foreign	0.520* (1.70)	1.081*** (3.17)	-0.142 (0.47)	0.847*** (2.62)	1.677*** (4.95)
e-domestic	0.292** (1.83)	0.539*** (3.07)	0.017 (0.11)	0.464*** (2.87)	0.839*** (4.96)
e-internal	0.243 (1.03)	0.366 (1.46)	0.095 (0.38)	0.379 (1.50)	0.549** (2.08)
e-outsourcing	0.525*** (3.16)	0.950*** (5.26)	0.038 (0.24)	0.585*** (3.49)	1.238*** (7.11)
turnover	0.460*** (20.68)		1.00	0.662*** (38.65)	
earnings index	-0.028*** (32.41)	-0.028*** (30.81)	-0.028*** (29.53)	-0.052*** (26.70)	-0.054*** (26.13)
other R&D in own industry	0.424*** (20.87)	0.359*** (16.15)	0.496*** (24.17)	0.773*** (35.90)	0.671*** (30.33)
no. of firms in own region	0.073*** (4.42)	0.103*** (5.92)	0.044** (2.48)	0.116*** (6.19)	0.158*** (8.11)
no. of firms in own industry	-0.058* (1.70)	-0.081** (2.15)	-0.039 (1.09)	-0.061* (1.66)	-0.100*** (2.62)
no. of establishments in a firm	0.003*** (3.05)	0.005*** (2.69)	0.000 (0.75)	0.004*** (6.08)	0.007*** (11.04)
dummy for exporting	1.055*** (17.05)	1.590*** (23.97)	0.415*** (6.94)	2.035*** (27.41)	2.888*** (38.70)
age	-0.011*** (8.11)	-0.006*** (3.84)	-0.018*** (12.69)	-0.020*** (13.87)	-0.013*** (8.56)
constant	-0.660 (1.38)	3.712*** (7.48)	-5.293*** (12.05)	-4.042*** (6.68)	2.794*** (4.70)
M&A aggregates	yes	yes	yes	yes	yes
legal form dummies	yes	yes	yes	yes	yes
year dummies	yes	yes	yes	yes	yes
number of observations	29 148	29 295	29 148	29 148	29 295
R^2 (pseudo R^2)	0.287	0.223	0.165	(0.076)	(0.062)

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %, z-values in parentheses [table 1]

The results reported in Table 1 show that becoming purchased by a foreign firm has no impact on the level or on the intensity of the target firm's R&D. Domestic M&As - another domestic firm as a purchaser - instead tend to reduce the purchased firm's R&D, more specifically the R&D intensity than the level of R&D. No substantial change in R&D activity – whether in relation to turnover or not – is associated with internal restructurings, whereas outsourcing seems to lead to an increase in the target firm's – the firm that sells out – R&D investments.

The impacts of M&As on the acquiring firms (Table 2) follow a different pattern. As a consequence of a cross-border acquisition the acquirer's R&D increases in absolute terms. The same result is obtained when firms' turnover is controlled without restricting the coefficient. But the acquirer's R&D intensity (column 3 in Table 2) does not change. The level of acquirers' R&D investments also increases in domestic M&As. This holds no longer when the turnover is also controlled and when the R&D intensity is considered. Domestic M&As even tend to decrease acquirers' R&D intensity.

Table 2. The impact of M&As on the R&D investments of purchasing firms
Differences-in-differences model

	OLS	OLS	OLS	TOBIT	TOBIT
d-foreign	0.225*** (2.12)	0.324*** (2.88)	0.054 (0.56)	0.164** (2.02)	0.311*** (3.72)
d-domestic	0.042 (0.56)	0.209*** (2.75)	-0.182** (2.56)	0.073 (1.31)	0.312*** (2.11)
d-internal	0.196 (0.75)	0.318 (1.20)	-0.021 (0.08)	0.464 (1.53)	0.659** (2.11)
e-foreign	1.077*** (7.25)	1.420*** (8.97)	0.468*** (3.38)	1.436*** (11.25)	1.948*** (14.89)
e-domestic	0.137 (1.36)	0.513*** (4.90)	-0.374*** (3.91)	0.278*** (3.09)	0.825*** (9.03)
e-internal	0.079 (0.33)	0.099 (0.41)	-0.019 (0.09)	0.113 (0.44)	0.116 (0.44)
turnover	0.409*** (17.97)		1.00	0.592*** (31.63)	
earnings index	-0.026*** (30.24)	-0.026*** (28.56)	-0.032*** (31.69)	-0.049*** (24.68)	-0.049*** (24.16)
other R&D in own industry	0.451*** (23.40)	0.405*** (19.76)	0.350*** (19.08)	0.804*** (37.37)	0.741*** (34.17)
no. of firms in own region	0.091*** (5.55)	0.116*** (6.92)	-0.024** (1.47)	0.151*** (8.09)	0.188*** (9.78)
no. of firms in own industry	-0.093*** (2.92)	-0.107*** (3.19)	-0.270*** (8.25)	-0.098*** (2.74)	-0.131*** (3.58)
no. of establishments in a firm	0.003** (3.24)	0.004*** (2.88)	0.001*** (2.74)	0.003*** (5.31)	0.005*** (8.38)
dummy for exporting	1.022*** (16.89)	1.397*** (22.39)	0.608*** (10.40)	1.979*** (26.48)	2.596*** (34.86)
age	-0.011*** (8.12)	-0.007*** (4.58)	-0.014*** (10.48)	-0.020*** (13.88)	-0.014*** (9.50)
constant	-0.644 (1.41)	3.055*** (6.50)	-2.565*** (6.25)	-4.316*** (7.20)	1.476** (2.55)
M&A aggregates	yes	yes	yes	yes	yes
legal form dummies	yes	yes	yes	yes	yes
year dummies	yes	yes	yes	yes	yes
number of observations	29 104	29 237	28 669	29 104	29 237
R^2 (pseudo R^2)	0.289	0.246	0.243	(0.074)	(0.065)

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %, z-values in parentheses

On the whole, the results obtained show that M&As tend to increase acquirers' R&D investments, while the impact on the target firm's R&D investments is zero. The most remarkable increase in R&D investments is experienced in a firm which buys a foreign firm. In these respects the discoveries of this study deviate from the findings of Bertrand and Zuniga (2006), who did not find

evidence for non-zero impacts.[3] Concerning the impacts on R&D intensities, both the impacts on target and acquiring firms follow a more consistent pattern in this study. Cross-border M&As have no impact on R&D intensities, whereas domestic M&As decrease the R&D intensity. But the negative impact on target firms is much larger than the respective negative impact on acquiring firms. As far as the impact on R&D intensity is concerned, the results obtained are parallel to the previous findings of Hall (1990) and Hitt *et al*. (1991), according to whom firms involved in acquisitions experience declines in their R&D intensities relative to other firms in their industry.

[3] It is obvious that the difference in the results is not only associated with the different countries – which have been investigated – but on the aggregation level of the data, too. Bertrand and Zuniga (2006) analyse the data set in which M&A incidences - concerning both target and acquiring firms - are aggregated to the industry and country level. Their panel includes 17 manufacturing industries, 14 OCECD countries and ten years. The small number of M&As registered in their data covers, however, only a small portion of actual frequency M&As in the countries and industries considered.

Table 3. The impact of M&As on the R&D investments of target firms
Differences-in-differences model

	OLS	OLS	OLS	TOBIT	TOBIT
d-foreign	0.037 (0.09)	-0.001 (0.00)	0.065 (0.17)	-0.050 (0.11)	-0.127 (0.27)
d-horizontal	-0.184 (0.60)	0.026 (0.08)	-0.452 (1.49)	-0.186 (0.51)	0.105 (0.27)
d-other than horizontal	-0.430*** (2.06)	-0.251 (1.07)	-0.621*** (2.93)	-0.661** (2.54)	-0.409 (1.51)
d-internal	0.043 (0.15)	0.246 (0.78)	-0.196 (0.68)	0.058 (0.18)	0.348 (1.05)
d-outsourcing	0.599*** (2.84)	1.055*** (4.55)	-0.054 (0.28)	0.715*** (3.18)	1.511*** (6.46)
e-foreign	0.513* (1.67)	1.055*** (3.08)	-0.130 (0.43)	0.818** (2.53)	1.609*** (4.76)
e-horizontal	0.116 (0.46)	0.444 (1.62)	-0.255 (1.04)	0.168 (0.70)	0.668*** (2.66)
e-other than horizontal	0.441** (2.47)	0.589*** (2.97)	0.267 (1.54)	0.718*** (3.50)	0.935*** (4.36)
e-internal	0.242 (1.02)	0.367 (1.47)	0.089 (0.36)	0.381 (1.51)	0.557** (2.11)
e-outsourcing	0.525*** (3.17)	0.940*** (5.20)	0.051 (0.31)	0.580*** (3.46)	1.213*** (6.98)
turnover	0.460*** (20.66)		1.00	0.656*** (38.16)	
earnings index	-0.028*** (32.38)	-0.028*** (30.79)	-0.028*** (29.50)	-0.052*** (26.64)	-0.053*** (25.99)
other R&D in own industry	0.424*** (20.86)	0.357*** (16.01)	0.498*** (24.33)	0.772*** (35.82)	0.669*** (30.26)
no. of firms in own region	0.073*** (4.41)	0.103*** (5.97)	0.042** (2.40)	0.116*** (6.21)	0.160*** (8.19)
no. of firms in own industry	-0.055 (1.55)	-0.046 (1.20)	-0.065* (1.75)	-0.024 (0..63)	-0.018 (0.47)
no. of establishments in a firm	0.003** (3.05)	0.005*** (2.70)	0.000 (0.83)	0.004*** (6.08)	0.007*** (10.88)
dummy for exporting	1.059*** (17.02)	1.620*** (24.46)	0.389*** (6.48)	2.075*** (27.67)	2.954*** (39.41)
age	-0.011*** (8.10)	-0.006*** (3.87)	-0.018*** (12.64)	-0.020*** (13.87)	-0.013*** (8.64)
constant	0.680 (1.41)	3.472*** (6.88)	-5.116*** (11.49)	-4.260*** (7.01)	2.170*** (3.63)
M&A aggregates	yes	yes	yes	yes	yes
legal form dummies	yes	yes	yes	yes	yes
year dummies	yes	yes	yes	yes	yes
number of observations	29 148	27 921	29 148	29 148	29 295
R^2 (pseudo R^2)	0.287	0.237	0.166	(0.076)	(0.063)

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %, z-values in parentheses

Table 4. The impact of M&As on the R&D investments of purchasing firms
Differences-in-differences model

	OLS	OLS	OLS	TOBIT	TOBIT
d-foreign	0.228**	0.332***	0.085	0.174**	0.330***
	(2.15)	(2.96)	(0.79)	(2.14)	(3.92)
d-horizontal	-0.212	-0.025	-0.597**	-0.203	0.130
	(0.87)	(0.10)	(2.52)	(0.85)	(0.53)
d-other than horizontal	0.059	0.213***	-0.164**	0.089	0.311***
	(0.73)	(2.61)	(2.00)	(1.50)	(5.10)
d-internal	0.192	0.327	0.002	0.466	0.675**
	(0.73)	(1.23)	(0.01)	(1.54)	(2.16)
e-foreign	1.067***	1.407***	0.566***	1.417***	1.926***
	(7.18)	(8.89)	(3.87)	(11.08)	(14.69)
e-horizontal	0.148	0.344*	-0.091	0.277	0.562***
	(0.78)	(1.74)	(0.47)	(1.50)	(2.96)
e-other than horizontal	0.125	0.485***	-0.390***	0.253***	0.773***
	(1.24)	(4.46)	(3.78)	(2.72)	(8.15)
e-internal	0.079	0.079	0.070	0.108	0.088
	(0.33)	(0.33)	(0.28)	(0.42)	(0.33)
turnover	0.410***		1.00	0.595***	
	(18.00)			(31.80)	
earnings index	-0.026***	-0.026***	-0.027***	-0.049***	-0.049***
	(30.14)	(28.52)	(28.34)	(24.65)	(24.18)
other R&D in own industry	0.460***	0.415***	0.524***	0.818***	0.754***
	(23.03)	(19.51)	(26.04)	(37.76)	(34.35)
no. of firms in own region	0.091***	0.116***	0.059***	0.150***	0.186***
	(5.53)	(6.88)	(3.36)	(8.01)	(9.69)
no. of firms in own industry	-0.106***	-0.118**	-0.096***	-0.117***	-0.147***
	(3.24)	(3.47)	(2.80)	(3.24)	(3.97)
no. of establishments in a firm	0.003***	0.004***	0.001**	0.003***	0.005***
	(3.26)	(2.89)	(2.18)	(5.28)	(8.27)
dummy for exporting	1.019***	1.397***	0.459***	1.956***	2.587***
	(16.83)	(22.34)	(7.66)	(26.07)	(34.65)
age	-0.011***	-0.007***	-0.018***	-0.020***	-0.014***
	(8.09)	(4.54)	(12.66)	(13.74)	(9.38)
constant	-0.651***	3.042***	-5.417***	-4.341***	1.465**
	(1.42)	(6.47)	(12.66)	(7.25)	(2.53)
M&A aggregates	yes	yes	yes	yes	yes
legal form dummies	yes	yes	yes	yes	yes
year dummies	yes	yes	yes	yes	yes
number of observations	29 104	29 237	29 104	29 104	29 237
R^2	0.289	0.246	0.164	(0.075)	(0.065)

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %, z-values in parentheses

The results from the analysis which divides M&As according to technological proximity and to geographical proximity are reported in Tables 3 - 6. It has been discovered that the acquisition tends to decrease the target firm's R&D activity and, in particular, R&D intensity when it is located in other industries (Table 3) or in other regions (Table 5). Such a negative impact is not found for the target firms which are located in the same industry or area as the acquirer. These negative impacts are partly compensated for by the increase in the acquirer's R&D activity (see Tables 4 and 6). This especially concerns the level acquirer's R&D investments in interregional M&As. Among acquiring firms the negative impact was, however, experienced insofar as the acquirer is located in the same

industry or region as the target firm. This impact was remarkably strong in intraregional M&As. The results obtained are, to some extent, surprising. The latter result, especially, is against all expectations.

Table 5. The impact of M&As on the R&D investments of target firms
Differences-in-differences model

	OLS	OLS	OLS	TOBIT	TOBIT
d-foreign	0.013 (0.03)	-0.038 (0.08)	0.051 (0.19)	-0.102 (0.22)	-0.204 (0.43)
d-intraregional	-0.257 (0.88)	-0.237 (0.75)	-0.301 (1.00)	-0.255 (0.72)	-0.307 (0.84)
d-interregional	-0.317 (1.41)	-0.028 (0.011)	-0.639*** (2.84)	-0.503* (1.80)	-0.066 (0.23)
d-internal	0.050 (0.18)	0.259 (0.83)	-0.193 (0.67)	0.071 (0.22)	0.367 (1.11)
d-outsourcing	0.603*** (2.85)	1.152*** (4.56)	-0.044 (0.23)	0.723*** (3.21)	1.523*** (6.50)
e-foreign	0.519* (1.69)	1.078*** (4.56)	-0.131 (0.43)	0.845*** (2.61)	1.664*** (4.91)
e-intraregional	0.349* (1.67)	0.586** (2.50)	0.128 (0.62)	0.499** (2.05)	0.900*** (3.54)
e-interregional	0.210 (1.11)	0.402** (1.96)	-0.018 (0.10)	0.366* (1.83)	0.631*** (3.03)
e-internal	0.242 (1.02)	0.366 (1.46)	0.092 (0.37)	0.378 (1.50)	0.550** (2.08)
e-outsourcing	0.524*** (3.16)	0.945*** (5.22)	0.049 (0.30)	0.585*** (3.49)	1.227*** (7.05)
turnover	0.462*** (20.54)		1.00	0.659*** (38.14)	
earnings index	-0.028*** (32.42)	-0.028*** (30.84)	-0.028*** (29.53)	-0.053*** (26.72)	-0.054*** (26.23)
other R&D in own industry	0.424*** (20.87)	0.359*** (16.16)	0.495*** (24.11)	0.773*** (35.88)	0.673*** (30.39)
no. of firms in own region	0.071*** (4.23)	0.105*** (6.02)	0.033* (1.86)	0.117*** (6.19)	0.166*** (8.44)
no. of firms in own industry	-0.064* (1.85)	-0.068* (1.80)	-0.078** (2.16)	-0.047 (1.26)	-0.066* (1.71)
no. of establishments in a firm	0.003*** (3.04)	0.005*** (2.70)	0.000 (0.78)	0.004** (6.10)	0.007*** (11.08)
dummy for exporting	1.048*** (16.94)	1.605*** (24.35)	0.376*** (6.35)	2.052*** (27.37)	2.925*** (38.97)
age	-0.011*** (8.13)	-0.006*** (3.84)	-0.018*** (12.72)	-0.020*** (13.82)	-0.013*** (8.55)
constant	-0.617*** (1.29)	3.629*** (7.18)	-4.938*** (11.22)	-4.116 (6.77)	2.513*** (4.20)
M&A aggregates	yes	yes	yes	yes	yes
legal form dummies	yes	yes	yes	yes	yes
year dummies	yes	yes	yes	yes	yes
number of observations	29 148	29 295	29 148	29 148	29 295
R^2 (pseudo R^2)	0.287	0.223	0.167	(0.076)	(0.062)

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %, z-values in parentheses

Table 6. The impact of M&As on the R&D investments of purchasing firms
Differences-in-differences model

	OLS	OLS	OLS	TOBIT	TOBIT
d-foreign	0.220**	0.317***	0.050	0.157*	0.302***
	(2.10)	(2.85)	(0.52)	(1.93)	(3.60)
d-intraregional	-0.733***	-0.667***	-0.872***	-1.059***	-0.996***
	(3.75)	(3.32)	(4.27)	(4.82)	(4.39)
d-interregional	0.110	0.282***	-0.120	0.171***	0.417***
	(1.36)	(3.39)	(1.58)	(2.77)	(6.59)
d-internal	0.182	0.300	-0.034	0.171	0.587**
	(0.70)	(1.14)	(0.13)	(1.47)	(2.05)
e-foreign	1.054***	1.393***	0.439***	1.408***	1.914***
	(7145)	(8.84)	(3.19)	(11.03)	(14.63)
e-intraregional	0.215	0.400***	-0.054	0.326**	0.587***
	(1.48)	(2.64)	(0.37)	(2.02)	(3.53)
e-interregional	0.209**	0.566***	-0.266***	0.367***	0.890***
	(2.03)	(5.24)	(2.77)	(3.87)	(9.22)
e-internal	0.067	0.080	-0.019	0.091	0.083
	(0.29)	(0.33)	(0.09)	(0.36)	(0.31)
turnover	0.407***		1.00	0.587***	
	(17.96)			(31.47)	
earnings index	-0.026***	-0.025***	-0.031***	-0.048***	-0.048***
	(29.50)	(28.07)	(30.80)	(24.19)	(23.87)
other R&D in own industry	0.454***	0.407***	0.355***	0.808***	0.743***
	(23.64)	(19.88)	(19.49)	(37.80)	(34.26)
no. of firms in own region	0.100***	0.124***	-0.014	0.164***	0.198***
	(6.11)	(7.39)	(0.84)	(8.70)	(10.23)
no. of firms in own industry	-0.078**	-0.101***	-0.244***	-0.074**	-0.123***
	(2.46)	(3.01)	(7.53)	(2.03)	(3.33)
no. of establishments in a firm	0.003***	0.004***	0.001***	0.003***	0.005***
	(3.27)	(2.91)	(2.61)	(5.17)	(8.22)
dummy for exporting	0.990***	1.378***	0.552***	1.941***	2.572***
	(16.38)	(22.14)	(9.52)	(25.87)	(34.40)
age	-0.011***	-0.007***	-0.013***	-0.020***	-0.014***
	(7.83)	(4.42)	(9.95)	(13.48)	(9.27)
constant	-0.956**	2.844***	-3.063***	-4.742	1.207***
	(2.09)	(6.05)	(7.52)	(7.83)	(2.07)
M&A aggregates	yes	yes	yes	yes	yes
legal form dummies	yes	yes	yes	yes	yes
year dummies	yes	yes	yes	yes	yes
number of observations	29 104	29 237	28 669	29 104	29 237
R^2	0.292	0.248	0.247	(0.075)	(0.066)

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %, z-values in parentheses

4.2. The robustness of the results

In the Appendix we also report the fixed effect estimates for the impacts of M&As on the level of R&D investments. R&D investments are then regarded as left-censored so that zero value is the censoring point. This analysis measures the impact of an M&A after one and two years, and so the impacts estimated are shorter than the respective impacts from the OLS (and Tobit) models which are reported in Tables 1-6. The results, however, are parallel with the previous results in Tables 1-6.

Only the impact after a domestic or another domestic than horizontal M&A on an acquirer's R&D investments is no longer positive.

The results obtained from the matching analysis are reported in the Appendix in Table A2. In this approach the number of M&As considered is decreased because in each treatment group for a given type of M&A (separately for targets and acquirers) such incidences are excluded that have been part of some other type of M&A during the year considered. In the matching approach the focus – insofar as the impact of an M&A is concerned - is also on a shorter period than in the OLS (difference-in-differences) models considered. In the matching procedure the choice to become part of a given type of M&A either as a target or as an acquirer is, however, controlled and therefore the results can be regarded as being reliable. The results obtained – reported in Table A2 – primarily support the previous results obtained from OLS models. The impacts discovered are, however, weaker; they are often zero when the respective OLS or Tobit -coefficients were non-zero. The matching approach also suggests rather strongly that R&D investments increase for the Finnish firms who buy foreign firms.

We also tested the robustness of the difference-in-difference estimates by enlarging the models to comprise the firms' indebtedness and tangible assets ratio. This test was motivated by Hall's (1990) point of view, according to which there is a link between leverage and the reduced R&D spending of firms. The inclusion of auxiliary variables did not change the results considerably.

5. CONCLUSIONS

In all, the results obtained tell that

(i) M&As lead to the duplication of R&D activity, especially at the regional level. As a consequence, the acquirer's R&D activity - both the level of R&D investments and R&D intensity – decreases;

(ii) an acquirer tends to cut the target firm's R&D activity in other areas and in other industries describes its effort to achieve control over all R&D activity under the expanded ownership. The acquirer evidently obtains control of the target firm's R&D activity insofar as it is located close – either technologically or geographically – wherefore the target firm's R&D activity in the same region or in the same industry is not reduced;

(iii) an acquirer decreases its own R&D in the same region, which is a mystery in some degree. Perhaps the duplication generated is, however, easier to remove by cutting R&D activity in the firm which is familiar to the management; and

(iv) in horizontal M&As neither the target firm nor the acquiring firm decreases the absolute level of R&D, and this is somewhat surprising, too. This result may reflect the preconception introduced by Colombo *et al*. (2004). According to them, the parties of M&A in horizontal acquisitions are culturally close to each other and are therefore not compelled to renew the management and to put weight on the shorter term, which would curtail R&D investments.

Table B1. Description of M&A variables

M&A-variable	Definition/measurement
d-foreign	A firm level average of the establishment level dummy, which is originally zero, but is added to by one every time an establishment is purchased by a foreign firm (in the data set for target firms) or is added to by one every time a firm to which an establishment belongs buys a foreign firm (in the data set for acquirers).
d-horizontal	A firm level average of the establishment level dummy, which is originally zero, but is added to by one every time an establishment is purchased by a domestic firm which has an establishment in the same (NACE3) industry as the purchased establishment (in the data set for target firms) or is added to by one every time a domestic firm to which an establishment belongs buys another firm which has an establishment in the same (NACE3) industry as the purchaser's establishment (in the data set for acquirers).
d-other domestic	A firm level average of the establishment level dummy, which is originally zero, but is added to by one every time an establishment is purchased by a domestic firm which has no establishment in the same (NACE3) industry as the purchased establishment (in the data set for target firms) or is added to by one every time a domestic firm to which an establishment belongs buys another firm which has no establishment in the same (NACE3) industry as the purchaser's establishment (in the data set for acquirers).
d-intraregional	A firm level average of the establishment level dummy, which is originally zero, but is added by one every time when an establishment is purchased by a domestic firm which has an establishment in the same (NUTS4) region as the purchased establishment (in the data set for target firms) or is added by one every time when a domestic firm to which an establishment belongs buys another firm which has establishment in the same (NUTS4) region as the purchaser's establishment (in the data set for acquirers).
d-interregional	A firm level average of the establishment level dummy, which is originally zero, but is added to by one every time an establishment is purchased by a domestic firm which has no establishment in the same (NUTS4) region as the purchased establishment (in the data set for target firms) or is added to by one every time a domestic firm to which an establishment belongs buys another firm which has no establishment in the same (NUTS4) region as the purchaser's establishment (in the data set for acquirers).
d-internal	A firm level average of the establishment level dummy, which is originally zero, but is added to by one every time an establishment is a target in a majority ownership change without the involvement of another company. For instance, management buy-outs, purchases by persons and other restructurings belong to this category of M&As (in the data set for target firms) or added to by one every time an establishment belongs to a firm which purchases an unrecognized Finnish company or which, in association with an ownership change, transforms from a target company into a new company (regarded as an acquirer) with a new ID code (in the data set for acquirers).
d-outsourcing	A firm level average of the establishment level dummy, which is originally zero, but is added to by one every time only a part of the target firm (one or more establishments) is purchased by a domestic acquirer (in the data set for target firms).
e-foreign	Is one during all years, if d-foreign changes at least once. Otherwise it is zero.
e-horizontal	Is one during all years, if d-horizontal changes at least once. Otherwise it is zero.
e-other domestic	Is one during all years, if d-other domestic changes at least once. Otherwise it is zero.
e-intraregional	Is one during all years, if d-intraregional changes at least once. Otherwise it is zero.
e-interregional	Is one during all years, if d-interregional changes at least once. Otherwise it is zero.
e-internal	Is one during all years if d-internal changes at least once. Otherwise it is zero.
e-outsourcing	Is one during all years if d-outsourcing changes at least once. Otherwise it is zero (only in the data set for target firms).

Table B2. Description of M&A aggregates

M&A-variable	Definition/measurement
	Data set for target firms Data set for acquirers
? -foreign in own industry	The sum of d-foreign variables for other firms in the same (NACE3-digit) industry
? -horizontal in own industry	The sum of d-horizontal variables for other firms in the same (NACE3) industry
? -other dom. in own industry	The sum of d-other domestic variables for other firms in the same (NACE3) industry
? -internal in own industry	The sum of d-internal variables for other firms in the same (NACE3) industry
? -outsourcing in own industry	The sum of d-outsourcong variables for other firms in the same (NACE3) industry

Table B3. Description of other variables in the establishment level data

Variables	Definition/measurement
R&D investments	the log (R&D investments + 1)
turnover	the log of a firm's nominal turnover
earnings index	earnings level index in the private sector
other R&D in own industry	the log of the other firms' R&D investments in the same (21- group) industry
no. of firms in own region	the log of the number of firms in the same (NUTS4) region
no. of firms in own industry	the log of the number of firms in the same (21-group) industry
no. of establishments in a firm	The number of firms' establishments
debts	log(100*(debts/total assets) + 100)
tangible assets ratio	log((tangibles assets/all assets) + 1)
dummy for exporting	Firm is involved in export activity = 1, otherwise 0.
age	The age of a firm is measured in years. The base year is not dependent on the firm's legal status.
Legal form dummies	Legal form of firm consists of 4 categories: category 1 (limited company), category 2 (mutual insurance company, savings bank or co-operative society), category 3 (governmental authority, governmental enterprise or public corporation), category 4 (Limited partnership).
Year dummies	1-15

Table A1. The impact of M&As on R&D investments

Fixed establishment effect estimates, Tobit model, becoming a target or an acquirer

	Targets	Targets	Targets	Acquirers	Acquirers	Acquirers
d-foreign$_{t-1}$	-0.661 (1.38)	-0.667 (1.39)	-0.666 (1.39)	0.404*** (2.94)	0.412*** (2.99)	0.390*** (2.83)
d-foreign$_{t-2}$	0.795 (1.58)	0.795 (1.58)	0.811 (1.61)	-0.116 (0.80)	-0.113 (0.78)	-0.097 (0.67)
d-domestic$_{t-1}$	0.383 (1.22)			0.224** (2.43)		
d-domestic$_{t-2}$	-0.272 (0.86)			-0.246** (2.55)		
d-horizontal$_{t-1}$		0.128 (0.20)			0.300 (1.01)	
d-horizontal$_{t-2}$		0.117 (0.18)			-0.146 (0.46)	
d-other domestic than horizontal$_{t-1}$		0.474 (1.30)			0.214** (2.18)	
d-other domestic than horizontal$_{t-2}$		-0.403 (1.10)			-0.255* (2.49)	
d-intraregional$_{t-1}$			1.048** (2.05)			0.250 (0.83)
d-intraregional$_{t-2}$			-0.834 (1.64)			-0.773** (2.41)
d-interregional$_{t-1}$			-0.118 (0.27)			0.215** (2.13)
d-interregional$_{t-2}$			0.173 (0.40)			-0.175* (1.68)
d-internal$_{t-1}$	-0.675* (1.86)	-0.677* (1.86)	-0.634* (1.75)	-0.158 (0.38)	-0.170 (0.41)	-0.136 (0.32)
d-internal$_{t-2}$	0.389 (1.02)	0.393 (1.03)	0.344 (0.90)	0.136 (0.31)	0.155 (0.35)	0.086 (0.20)
d-outsourcing$_{t-1}$	0.253 (0.80)	0.250 (0.79)	0.240 (0.75)			
d-outsourcing$_{t-2}$	0.026 (0.07)	0.023 (0.07)	0.025 (0.07)			
turnover$_{t-1}$	0.558*** (12.62)	0.557*** (12.59)	0.556*** (12.53)	0.561*** (12.70)	0.558*** (12.62)	0.559*** (12.63)
turnover$_{t-2}$	-0.081* (1.95)	-0.079* (1.92)	-0.067 (1.61)	-0.084** (2.03)	-0.082** (1.98)	-0.082** (1.98)
earnings index$_{t}$	0.003 (1.62)	0.003* (1.68)	0.003 (1.55)	0.005** (2.21)	0.004** (2.05)	0.005** (2.26)
other R&D in own industry$_{t-1}$	0.297*** (10.44)	0.297*** (10.44)	0.289*** (10.13)	0.288*** (10.07)	0.297*** (10.32)	0.296*** (10.32)
no. of firms in own region$_{t-1}$	0.067*** (3.09)	0.068*** (3.11)	0.064*** (2.94)	0.019 (0.89)	0.019 (0.89)	0.022 (1.03)
no. of firms in own industry$_{t-1}$	-0.199*** (4.19)	-0.207*** (4.29)	-0.216*** (4.50)	-0.180*** (3.96)	-0.187*** (4.10)	-0.155*** (3.33)
no. of establishments in a firm$_{t-1}$	0.004*** (3.10)	0.004*** (3.10)	0.004*** (2.98)	0.004*** (3.16)	0.004*** (3.02)	0.004*** (3.06)
M&A aggregates$_{t-1}$	Yes	yes	yes	yes	yes	yes
M&A aggregates$_{t-1}$	Yes	yes	yes	yes	yes	yes
year dummies	Yes	yes	yes	yes	yes	yes
constant	-4.987*** (7.80)	-4.975*** (7.79)	-4.827*** (7.54)	-4.873*** (7.78)	-4.857*** (7.73)	-5.157*** (8.10)
number of observations	11 545	11 545	11 545	11 521	11 521	11 521
rho (stand.dev. in parentheses)	0.742 (0.007)	0.742 (0.007)	0.741 (0.007)	0.744 (0.007)	0.744 (0.007)	0.743 (0.007)

* Significant at 10 %, ** Significant at 5 %, *** Significant at 1 %, rho = fraction of variance due to u_i

z-values in parentheses

Table A2. The impact of M&As on R&D investments in matching
The average treatment effect on the treated (ATT)

	Impact on the target's R&D investments			Impact on the acquirer's R&D investments		
	from t-1 to t	from t-1 to t+1	from t-1 to t+2	from t-1 to t	from t-1 to t+1	from t-1 to t+2
cross-border	0	0	0	+++	+++	++
domestic	0	0	0	0	++	0
horizontal	0	0	0	0	0	0
other than horizontal	-	0	0	++	+	+
intraregional	--	0	0	0	0	0
interregional	0	0	0	+	+	0

+ positive and significant at10 %, ++ positive and significant at 5 %, +++ positive and significant at 1 %,
- negative and significant at 10 %, -- negative and significant at 5 %, --- negative and significant at 1 %,
0 zero.

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